Technical Memorandum
Lake Wequaquet Summer 2010 Water Quality Monitoring

To: Rob Gatewood, Director, Conservation Division, Town of Barnstable

From: Ed Eichner, Senior Water Scientist, Coastal Systems Program, SMAST, UMASSD
Brian Howes, Director, Coastal Systems Program, SMAST, UMASSD

RE: Lake Wequaquet 2010 water quality monitoring

Date: March 23, 2011

Background: In 2008, SMAST-CSP completed the Lake Wequaquet Water Quality Assessment report for the Town of Barnstable and the Cape Cod Commission.[1] This project report included: 1) a delineation of an overall Lake watershed with subwatersheds to five lake sub-basins including Bearses and Gooseberry Ponds, 2) collection of seven monthly water quality samples and field readings between May and November 2007 at selected depths in each of the basins and at the stream outlet, 3) development of water, nitrogen, and phosphorus budgets for inflows and outflows for the lake and each of its basins, and 4) review of the ecological status of the lake, comparison of its conditions to state water quality regulatory limits, and development of recommendations to address data gaps/issues and provide for future water quality management. The recommendations in the final Lake Wequaquet Report included the following:

a. Collect and test lake sediment cores to measure phosphorus regeneration potential,
b. Conduct a refined aquatic plant survey of the lake to gauge rooted plants role in the phosphorus budget,
c. Establish a regular monitoring program to gauge year-to-year fluctuations and track worsening conditions, and
d. Develop an overall management plan for the lake, including use of its surface and acceptable water quality.[2]

Current Project: In order to begin work on recommendation "c", a regular monitoring plan, the Town of Barnstable Conservation Division worked with SMAST-CSP and the Wequaquet Lake Protective Association (WLPA) to develop a project to collect samples during the summer of

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[1] Eichner, E. 2008. Lake Wequaquet Water Quality Assessment. Completed for the Town of Barnstable and the Cape Cod Commission. Coastal Systems Program, School of Marine Science and Technology, University of Massachusetts Dartmouth. 81 pp.
[2] *Ibid*., pp. 63-64.

2010. In order to update the status of the lake water quality, SMAST-CSP was also asked to provide this brief technical memorandum comparing the 2007 and 2010 monitoring results.

Monitoring Protocols: Water quality samples were collected in 2010 by WLPA volunteers at the same five basin locations and same depths sampled during 2007. GPS coordinates of the prior sampling locations were provided to WLPA volunteers to ensure consistency. As in 2007, samples were collected over the deepest location in each basin. Sampling protocols followed the same PALS-developed procedures used in 2007 for sample handling and field data collection (*i.e.*, dissolved oxygen and temperature profiles and Secchi depth readings).[3] Water quality samples were analyzed at the SMAST-CSP Analytical Facility[4] using the same procedures and protocols used in 2007.

Comparison of 2007 and 2010 Monitoring Results: All laboratory and field monitoring results are included in Appendix A. Field data generally show that water quality conditions were worse in Lake Wequaquet during 2010 with occasional measurement of conditions failing to meet state standards. These conditions are generally also confirmed by the results of the water quality assays. The following discussion focuses on the most important findings.

a. *Dissolved Oxygen and Temperature*: The state surface water regulations[5] have numeric standards for both dissolved oxygen and temperature in lakes. Given its depth and temperature regime, Lake Wequaquet is required by these regulations to sustain minimum dissolved oxygen concentrations of 5.0 mg/l or higher.

During the 2007 sampling, project staff found that bottom water dissolved oxygen levels periodically dropped below the 5.0 mg/l standard in both the deep, main basin of Lake Wequaquet and in Bearses Pond. Data showed that these conditions are transitory and are related to the Lake's structure: it is relatively shallow with a large surface area and these characteristics allow easy, rapid mixing of the entire water column. Any oxygen removed from the water column by sediment demand is replenished by mixing of the water column and contact of diminished water with the atmosphere. During 2007, concentrations less than 5 mg/l were found as shallow as 8 m in the main basin in July and August and as shallow as 5 m in Bearses Pond in June, July and August. Other sampling locations and most other sampling dates showed relatively consistent and fully saturated conditions throughout the water column.

During 2010 sampling season, the earliest readings were collected in July and these had lower oxygen concentrations than any recorded during 2007. On July 19, concentrations at the deep, main basin were not only less than 5 mg/l, but were also depleted to less than 1 mg/l (Figure 1). Concentrations less than 1 mg/l are considered hypoxic and may result in an anoxic sediment surface. Hypoxic conditions at the sediment/water interface generally cause significant release of phosphorus from the sediments into the water column, due to chemical desorption. Hypoxic concentrations extended from the bottom to a depth of 6 m, which means that more than a third of the bottom of the main basin was hypoxic/anoxic.

[3] Ibid, p. 13.
[4] Facility manager, Sara Sampieri, ssampieri@umassd.edu
[5] 314 Code of Massachusetts Regulations 4.00: Massachusetts Surface Water Quality Standards

July 2010 conditions at Bearses Pond were also worse than 2007 with hypoxic conditions beginning at 5 m depth and < 5 ppm concentration (state regulatory standard) from 4 m to the bottom. These conditions may have been exacerbated by the warm temperatures in June and July 2010; water temperatures in the July sampling were generally above 27°C, while the highest temperatures recorded during 2007 were just above 24°C. Air temperatures for the four weeks prior to the July 19 sampling were above average with temperatures above 90°F recorded on July 4th weekend. Higher temperature water holds less dissolved oxygen.

Based on all available data, we know that oxygen depletion occurs in the main basin and Bearses Pond each summer but the duration of these events and the balancing periodic aeration is not captured by the once or twice a month samplings. One way to determine the pattern of oxygen depletion and re-aeration is to use continuously recording sensors coupled to the ongoing monitoring program. This information would be useful for calibrating the monitoring data to determine the actual oxygen minima (and their role in sediment phosphorus regeneration) in each of the basins.

The frequency and duration of these low dissolved oxygen concentrations near the sediments create conditions that could prompt significant algal blooms. Anoxic conditions allow phosphorus stored in the upper layers of the sediment to be rapidly released by chemical desorption. Coupling of this phosphorus release with the vertical mixing characteristics of Lake Wequaquet, results in periodic mixing of these extra nutrients into the upper water column, which creates conditions favoring rapid growth of phytoplankton, especially blue-greens. Blue greens were found in the 2007 sampling and can outcompete other phytoplankton in phosphorus-enriched conditions.

b. *Secchi readings*: Secchi measurements are a measure of water transparency; more transparent water allows light to penetrate deeper into the water column and increases the volume of water and area of the bottom where plants can survive. The state does not have regulatory numbers for Secchi measurements, but it is an indirect measure of how much phytoplankton biomass that present nutrient levels in Lake Wequaquet are supporting (how much phosphorus is available).

In order to allow easy comparison among sites, a measure called relative Secchi depth is used. This measure divides the Secchi transparency depth by the total depth so that readings at different locations and different pond levels at the same location can be compared; it is a measure of the percentage of the water column that light can penetrate.

During the summer of 2007, average relative Secchi readings in Lake Wequaquet were between 39% and 60% in the five basins with the worst (39%) readings at the main, deep basin sampling location.[6] In 2010, average relative Secchi readings at all sampling locations are significantly ($\rho<0.05$) lower; average readings range between 22% and 52% (Figure 2). The uncorrected Secchi readings also have these same statistically significant relationships. These Secchi readings (or reduced transparency) are consistent with more phosphorus availability and greater phytoplankton growth.

[6] Eichner, E. 2008. Lake Wequaquet Water Quality Assessment. pp. 20-23.

c. *Chemical Assays*: 2010 water quality samples were analyzed at the SMAST-CSP Analytical Facility for the traditional PALS analytes: pH, alkalinity, chlorophyll *a*, phaeophytin, total phosphorus, and total nitrogen. Generally 2010 averages are not significantly ($\rho<0.05$) different than sample results from 2007 over the same sampling period, although many of the 2010 averages were higher, most notably for chlorophyll *a* at the main and north sampling locations in the main basin of Lake Wequaquet and in Gooseberry Pond (Table 1). Nutrient concentrations (TP and TN) were also higher at these locations although not statistically significant increases. Figure 3 shows comparison of 2007 and 2010 average surface TP concentrations, as well as 1986 data from IEP[7]. As noted in the 2008 assessment report, the 2007 surface TP concentration at all sampling locations (except the north main basin) are significantly higher than those measured by IEP in 1986.[8] The higher TP and chlorophyll *a* concentrations in 2007 and 2010 versus those two decades before are consistent with a higher annual nutrient load to the water column and the observed low dissolved oxygen concentrations in deep waters. It is also likely that the formation of low oxygen bottom water results in a positive feedback which increases the water column available P by facilitating the chemical desorption of P from the sediments.

   Among the analytes, only pH has significantly ($\rho<0.05$) higher average readings in 2010 compared to 2007 at almost all the sampling locations. These average readings were also higher than the 1986 average readings, which were also generally higher than the 2007 averages.

   It is also worth noting that 2010 TP data confirmed a pattern observed in 2007. In 2007, TP concentrations declined as the summer progressed, peaking in July and August and declining to almost half of the peak by the September sampling. It has been suggested that this decline is due to the rooted plant community exhausting available phosphorus in surrounding sediments and removing available TP from the water column. This hypothesis was one of the reasons staff recommended a rooted plant survey in the 2008 assessment report.

Conclusions: In general, the 2010 sampling results generally show lower water quality conditions in Lake Wequaquet than observed in 2007. 2010 field and laboratory results are generally consistent with the anoxic conditions measured in July in the Main Basin. These anoxic conditions would have exposed approximately 34% of the bottom sediments to conditions favoring release of sediment phosphorus to the water column. These conditions are worse than any measured during 2007. Given that the Lake's depth and surface area characteristics favor regular vertical mixing of the water column, sediment phosphorus released during hypoxia/anoxia would be readily mixed into the water column to prompt phytoplankton growth. Average chlorophyll *a* concentrations, which are a direct measure of phytoplankton biomass, are higher in the main basin (at both stations) in 2010 than in 2007.

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[7] IEP, Inc. and K-V Associates. 1989. Diagnostic/Feasibility Study of Wequaquet Lake, Bearses, and Long Pond. Prepared for Town of Barnstable, Conservation Commission. Sandwich and Falmouth, MA.

[8] Eichner, E. 2008. Lake Wequaquet Water Quality Assessment.

The 2010 sampling results reinforce the recommendations made in the 2008 assessment report. Only regular sampling of the lake, as recommended in the 2008 report, can gauge year to year fluctuations and assess whether the conditions observed in 2010 are part of a trend or strictly due to the high temperatures experienced in July 2010. Therefore, it is again recommended that the town continue regular water quality sampling of Lake Wequaquet.

The town may also want to consider adding an automated dissolved oxygen monitoring device to the monitoring program, in order to gauge the frequency and duration of low oxygen events since these are so crucial to the management of water quality conditions in the lake.

Another recommendation in the 2008 assessment report that is reinforced by the 2010 results is for the town to collect and incubate sediment cores. Incubation of cores would allow the town to accurately measure the rate and total amount of phosphorus released from the sediments under toxic and anoxic conditions, was well as how much chemical desorption occurs. Knowing this information would allow the town to assess whether the most cost-effective water quality management for Lake Wequaquet and its basins is to control sediment phosphorus, watershed phosphorus (from wastewater, fertilizers and runoff), or some combination of both.

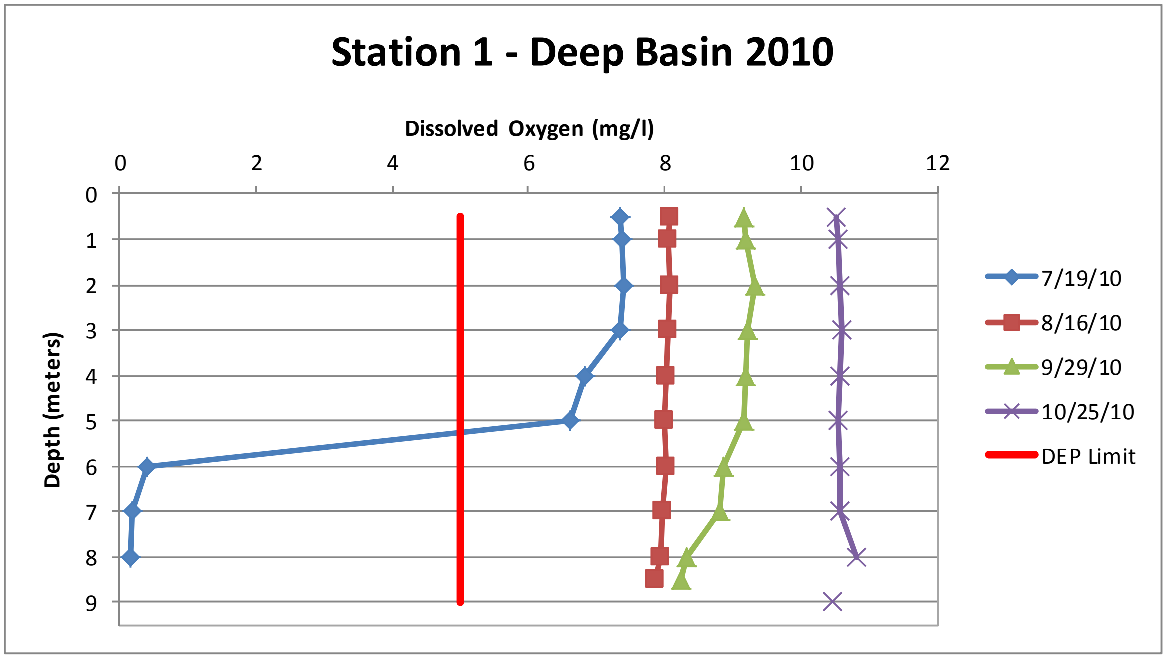
The 2008 assessment also recommended that the town consider completing an aquatic plant survey. SMAST staff offered that this could be completed using a camera-equipped, Autonomous Underwater Vehicle that could also provide an updated bathymetric map and a survey for freshwater mussels, which have been a management concern in other ponds in the town (*e.g.*, Mystic’s alum treatment). Establishing the extent and density of rooted aquatic plants would help to refine the phosphorus budget for the lake and assess how plant populations (both rooted and phytoplankton) would respond to phosphorus reductions. This survey method is now a standard part of SMAST's lake monitoring program.

As always, SMAST staff continue to be available to assist the Town of Barnstable with assessment of lake and pond water quality and water quality management options.

Table 1. Average Concentrations of Water Quality Parameters in Lake Wequaquet based on sampling completed July through October 2010. Parameters are alkalinity as CaCO3, chlorophyll *a*, phaeophytin, total phosphorus, and total nitrogen. Averages are based on four 2010 sampling runs: July 19, August 16, September 29, and October 25. Units are presented in the column headers. Averages from 2010 were compared to 2007 averages from the same time of year, which is discussed in Lake Wequaquet Water Quality Assessment (Eichner, 2008); any comparisons with statistically significant higher average concentrations in 2010 than 2007 are indicated by the colored shading. It should be noted that the pH readings in 2010 are consistently higher at most sampling locations and most depths than comparable readings in 2007. All laboratory analyses in 2007 and 2010 were completed at the Coastal Systems Analytical Facility at the School for Marine Science and Technology (SMAST), University of Massachusetts Dartmouth.

			AVERAGES					
BASIN	**Station**	**Depth**	**pH**	**Alk mg/L CaCO3**	**Chl a µg/L**	**Phaeo µg/L**	**TP µg/l**	**TN mg/l**
Main Basin	STA1	shallow	6.75	5.88	6.30	1.99	17.77	0.47
	STA1	deep	6.59	6.35	5.60	45.90	153.46	1.39
North Main Basin	STA2	shallow	6.96	5.93	6.42	2.61	23.08	0.49
	STA2	deep	7.06	5.95	6.69	2.64	27.63	0.52
South Basin	STA3	shallow	7.08	5.33	2.60	1.95	20.74	0.46
	STA3	deep	6.88	5.45	6.53	2.06	27.76	0.49
Gooseberry Pond	STA4	shallow	7.01	4.92	3.97	1.51	29.07	0.62
	STA4	deep	7.02	4.94	4.27	1.72	29.60	0.57
Bearses Pond	STA5	shallow	7.07	6.46	5.12	1.39	15.92	0.45
	STA5	deep	7.05	6.51	4.62	2.41	20.50	0.46

significantly higher (ρ<0.05) in 2010 compared to 2007 (July to October readings)



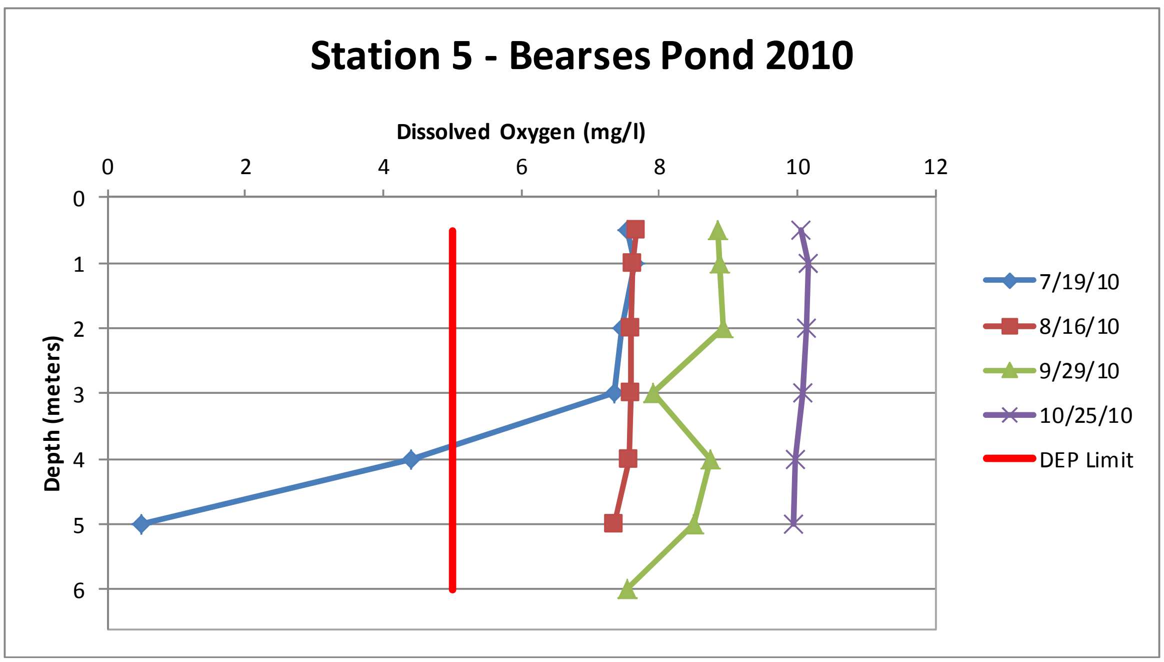


Figure 1. 2010 dissolved oxygen concentrations in Main Basin and Bearses Pond of Lake Wequaquet. Deep concentrations on July 19 at these two sampling locations are less than the state regulatory surface water quality limit of 5 mg/l (shown by the red line) and are anoxic (<1 mg/l) at the deepest measuring point. These concentrations are lower than any observed in 2007 and may be due to higher temperatures measured during 2010. Dissolved oxygen concentrations in other Lake Wequaquet basins were above 5 mg/l on all sampling dates. Anoxic conditions in deep waters can cause chemical desorption of phosphorus from sediments which can then be mixed into the water column to prompt phytoplankton blooms. High phosphorus concentrations can also favor blooms of blue-green phytoplankton/bacteria.

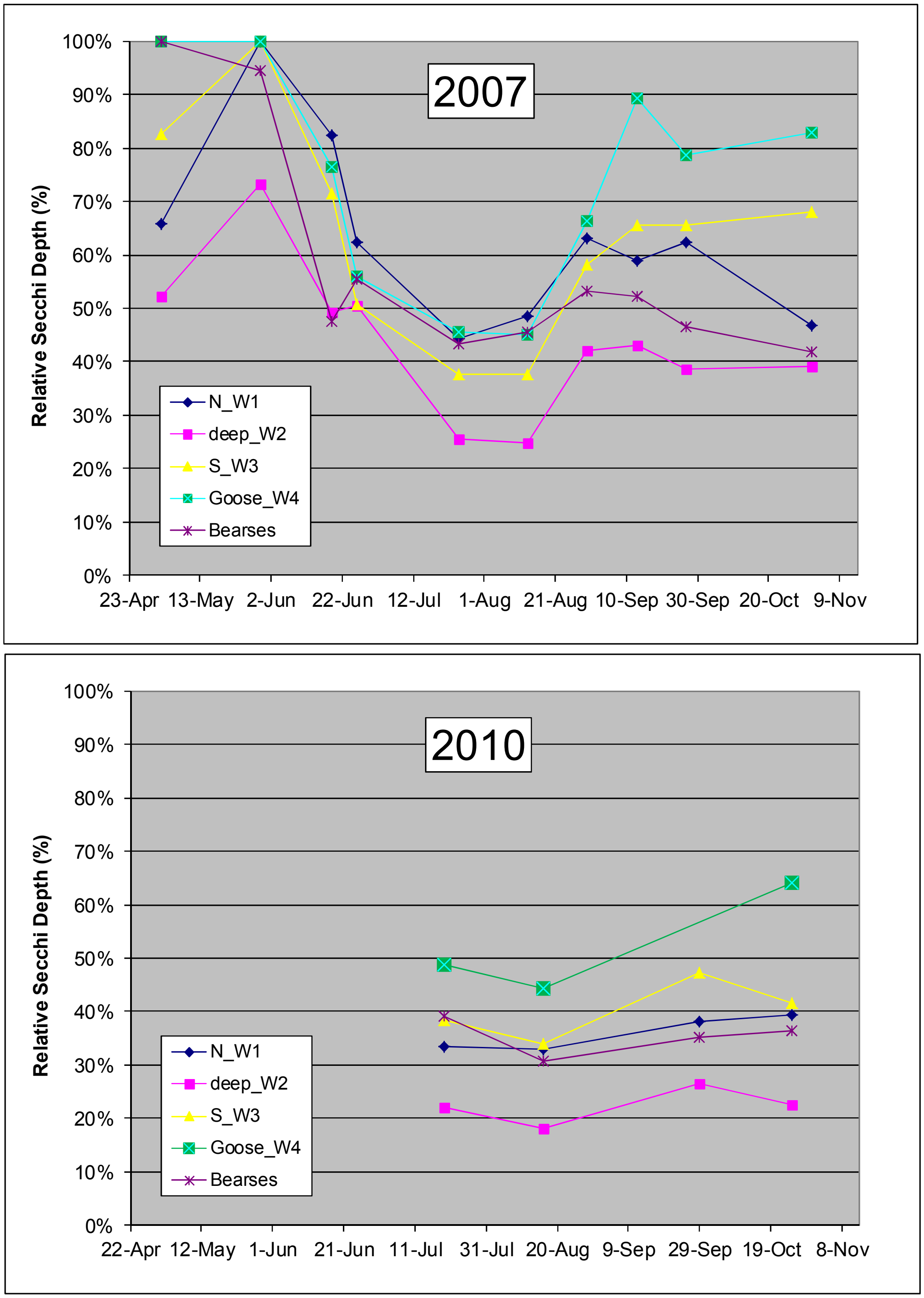


Figure 2. Relative Secchi readings in Lake Wequaquet in 2007 and 2010. Secchi readings collected at same sampling locations in both 2007 and 2010. 2010 readings were collected on: July 19, August 16, September 29, and October 25. In 2010, average relative Secchi readings at all sampling locations are significantly ($\rho<0.05$) lower than 2007 over the same sampling range. These readings are consistent with more phosphorus availability and greater phytoplankton growth.

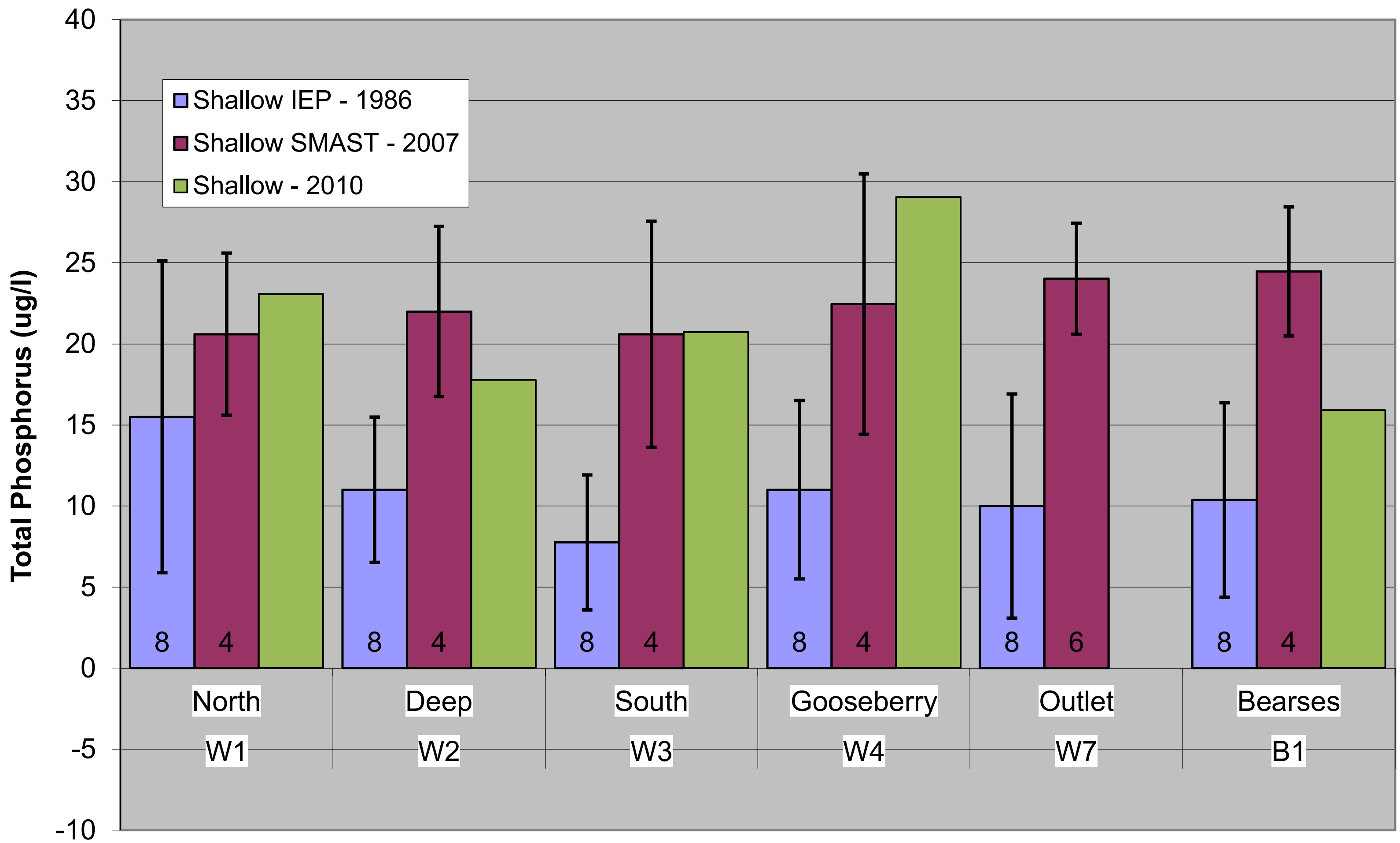


Figure 3. Average surface total phosphorus concentrations in Lake Wequaquet sampling locations in 1986, 2007, and 2010. TP concentrations in 2007 and 2010 are not statistically different, although 2007 concentrations are all significantly higher than those in 1986 except for the North Main basin site. All 2010 deep station TP averages are not significantly different from the corresponding 2007 averages, except for a significantly ($\rho<0.05$) higher concentration at the Main Deep basin. This deep station difference is consistent with the anoxic conditions at this location resulting in both chemical release and regeneration of sediment phosphorus.

Appendix A. 2010 Lake Wequaquet Sampling Data

Coastal Systems Group
SMAST
Umass Dartmouth
706 Rodney French Blvd
New Bedford, Ma 02744

Pond Name	Date	# of Samples	Sample Depth (m)	Pond Depth (m)	Secchi disappear (m)	Secchi reappear (m)	Average Secchi (m)	% Secchi	DO (mg/L)	Temp ©	pH	Alk mg/L CaCO3	Chl a ug/L	Phaeo ug/L	TP uM	TN uM
STA1	7/19/2010	2	0.5	9.5	2.2	2	2.10	22.1%	7.35	27.6	7.08	8.1	4.51	0.57	0.72	32.55
STA1	7/19/2010		1						7.38	27.6						
STA1	7/19/2010		2						7.4	27.6						
STA1	7/19/2010		3						7.35	27.5						
STA1	7/19/2010		4						6.82	26.9						
STA1	7/19/2010		5						6.62	26.8						
STA1	7/19/2010		6						0.4	23.9						
STA1	7/19/2010		7						0.18	21.4	6.55	10.4	<0.05	68.62	1.37	36.69
STA1	7/19/2010		8						0.16	19						
STA1	7/19/2010		8.5													
STA2	7/19/2010	2	0.5	5.4	1.8	1.8	1.80	33.3%	7.25	27.7	7.02	7.9	4.80	0.89	0.92	33.44
STA2	7/19/2010		1						7.45	27.7						
STA2	7/19/2010		2						7.42	27.7						
STA2	7/19/2010		3						7.32	27.5						
STA2	7/19/2010		4						6.12	26						
STA2	7/19/2010		4.5						5.4	26.7	7.14	8.1	5.46	0.97	0.83	38.77
STA3	7/19/2010	2	0.5	6.9	2.6	2.7	2.65	38.4%	7.2	27.4	7.18	7.1	3.23	0.66	0.89	32.85
STA3	7/19/2010		1						7.1	27.8						
STA3	7/19/2010		2						6.91	27.8						
STA3	7/19/2010		3						7	27.8						
STA3	7/19/2010		4						6.9	27.8	6.64	7.7	16.99	1.09	1.62	37.88
STA3	7/19/2010		5													
STA3	7/19/2010		5.5													
STA4	7/19/2010	2	0.5	4	1.9	2	1.95	48.8%	7.15	28.2	6.9	7.1	6.40	1.25	1.33	47.35
STA4	7/19/2010		1						7	28.2						
STA4	7/19/2010		2						6.8	28						
STA4	7/19/2010		3						6.5	27.7						
STA4	7/19/2010		3.5						6.95	27.2	6.83	7.2	8.04	2.52	1.51	49.42
STA4	7/19/2010		4													
STA5	7/19/2010	2	0.5	6	2.5	2.20	2.35	39.2%	7.55	28.2	7	7.7	5.18	0.31	0.58	33.44
STA5	7/19/2010		1						7.64	28.2						
STA5	7/19/2010		2						7.45	28.2						
STA5	7/19/2010		3						7.35	28.1						
STA5	7/19/2010		4						4.4	24.8						
STA5	7/19/2010		5						0.5	20.6	6.99	8	5.60	1.80	0.66	33.73
STA1	8/16/2010	2	0.5	9.40	1.42	2.00	1.71	18.2%	8.08	24.9	6.65	7.6	1.98	0.76	0.75	31.07
STA1	8/16/2010		1.0						8.06	25.1						
STA1	8/16/2010		2.0						8.08	25.1						
STA1	8/16/2010		3.0						8.05	25.1						
STA1	8/16/2010		4.0						8.03	25.1						
STA1	8/16/2010		5.0						8.00	25.1						
STA1	8/16/2010		6.0						8.01	25.1						
STA1	8/16/2010		7.0						7.98	25.1						
STA1	8/16/2010		8.0						7.94	25.1	6.73	8.3	1.36	1.39	1.09	34.33
STA1	8/16/2010		8.5						7.87	25.0						
STA2	8/16/2010	2	0.5	5.90	1.90	2.00	1.95	33.1%	8.20	24.9	6.82	8.0	0.74	3.76	0.87	41.13
STA2	8/16/2010		1.0						8.15	25.1						
STA2	8/16/2010		2.0						8.13	25.1						
STA2	8/16/2010		3.0						8.12	25.1						
STA2	8/16/2010		4.0						8.11	25.1						
STA2	8/16/2010		5.0						8.07	25.1	6.86	7.7	0.51	1.75	0.89	35.81
STA3	8/16/2010	2	0.5	6.86	2.40	2.25	2.33	33.9%	8.17	25.0	6.85	6.7	1.21	0.95	0.76	37.88
STA3	8/16/2010		1.0						8.13	25.1						
STA3	8/16/2010		2.0						8.12	25.2						
STA3	8/16/2010		3.0						8.10	25.2						
STA3	8/16/2010		4.0						8.09	25.2						
STA3	8/16/2010		5.0						8.07	25.2						
STA3	8/16/2010		5.5						ND	ND	6.84	6.6	1.13	1.20	0.84	37.88
STA4	8/16/2010	2	0.5	4.51	2.00	2.00	2.00	44.3%	8.18	25.1	6.91	6.8	1.64	0.79	0.96	48.24
STA4	8/16/2010		1.0						8.15	25.3						
STA4	8/16/2010		2.0						8.11	25.4						
STA4	8/16/2010		3.0						8.05	25.4						
STA4	8/16/2010		3.5						ND	ND	7.05	6.8	1.94	0.90	0.83	40.84
STA4	8/16/2010		4.0						8.04	25.4						
STA5	8/16/2010	2	0.5	6.00	1.90	1.80	1.85	30.8%	7.66	25.2	6.95	9.3	1.99	0.85	0.89	34.62
STA5	8/16/2010		1.0						7.61	25.3						
STA5	8/16/2010		2.0						7.59	25.3						
STA5	8/16/2010		3.0						7.58	25.3						
STA5	8/16/2010		4.0						7.57	25.3						
STA5	8/16/2010		5.0						7.35	25.2	6.92	9.2	1.47	1.04	0.77	32.55

Pond Name	Date	# of Samples	Sample Depth (m)	Pond Depth (m)	Secchi disappear (m)	Secchi reappear (m)	Average Secchi (m)	% Secchi	DO (mg/L)	Temp ©	pH	Alk mg/L CaCO3	Chl a ug/L	Phaeo ug/L	TP uM	TN uM
STA1	9/29/2010	2	0.5	9.47	2.46	2.55	2.51	26.5%	9.15	21.9	6.98	7.3	6.88	0.94	0.36	31.66
STA1	9/29/2010		1.0						9.18	21.9						
STA1	9/29/2010		2.0						9.32	21.6						
STA1	9/29/2010		3.0						9.22	21.5						
STA1	9/29/2010		4.0						9.18	21.3						
STA1	9/29/2010		5.0						9.15	21.2						
STA1	9/29/2010		6.0						8.85	21.2						
STA1	9/29/2010		7.0						8.82	20.9						
STA1	9/29/2010		8.0						8.33	20.8						
STA1	9/29/2010		8.5						8.25	20.7	6.37	6.0	9.52	107.55	16.96	292.15
STA2	9/29/2010	2	0.5	6.60	2.62	2.40	2.51	38.0%	9.31	21.9	6.79	7.0	5.18	1.20	0.75	31.07
STA2	9/29/2010		1.0						9.35	21.9						
STA2	9/29/2010		2.0						9.37	21.6						
STA2	9/29/2010		3.0						9.40	21.5						
STA2	9/29/2010		4.0						9.38	21.4						
STA2	9/29/2010		5.0						9.17	21.2						
STA2	9/29/2010		5.5						ND	ND	7.04	7.2	5.98	2.45	0.88	36.69
STA2	9/29/2010		6.0						9.05	21.1						
STA3	9/29/2010	2	0.5	6.79	3.20	3.23	3.22	47.3%	9.35	22.0	7.02	6.7	2.03	3.71	0.35	30.18
STA3	9/29/2010		1.0						9.28	21.9						
STA3	9/29/2010		2.0						9.12	21.8						
STA3	9/29/2010		3.0						9.13	21.8						
STA3	9/29/2010		4.0						9.10	21.7						
STA3	9/29/2010		5.0						8.12	21.7						
STA3	9/29/2010		6.0						8.82	21.6	6.97	6.7	3.97	3.11	0.68	31.66
STA5	9/29/2010	2	0.5	6.60	2.35	2.29	2.32	35.2%	8.85	22.5	7.04	7.9	4.46	1.23	0.29	30.18
STA5	9/29/2010		1.0						8.87	22.2						
STA5	9/29/2010		2.0						8.93	22.0						
STA5	9/29/2010		3.0						7.90	21.6						
STA5	9/29/2010		4.0						8.75	21.5						
STA5	9/29/2010		5.0						8.50	21.5						
STA5	9/29/2010		5.5						ND	ND	7.10	7.9	4.44	1.99	0.82	33.73
STA5	9/29/2010		6.0						7.55	21.1						
STA1	10/25/2010	2	0.5	9.55	2.20	2.09	2.15	22.5%	10.51	13.4	6.30	0.5	11.84	5.68	0.47	38.17
STA1	10/25/2010		1.0						10.54	13.3						
STA1	10/25/2010		2.0						10.56	13.2						
STA1	10/25/2010		3.0						10.59	13.1						
STA1	10/25/2010		4.0						10.58	13.1						
STA1	10/25/2010		5.0						10.55	13.1						
STA1	10/25/2010		6.0						10.58	13.1						
STA1	10/25/2010		7.0						10.57	13.1						
STA1	10/25/2010		8.0						10.82	13.1	6.71	0.7	11.51	6.02	0.40	33.44
STA1	10/25/2010		9.0						10.47	13.1						
STA2	10/25/2010	2	0.5	5.10	1.97	2.04	2.01	39.3%	10.57	13.4	7.19	0.8	14.96	4.59	0.44	33.73
STA2	10/25/2010		1.0						10.59	13.4						
STA2	10/25/2010		2.0						10.63	13.3						
STA2	10/25/2010		3.0						10.62	13.2						
STA2	10/25/2010		4.0						10.61	13.2	7.18	0.8	14.82	5.42	0.97	36.99
STA3	10/25/2010	2	0.5	6.87	2.80	2.90	2.85	41.5%	10.48	13.0	7.28	0.8	3.95	2.48	0.69	31.66
STA3	10/25/2010		1.0						10.49	13.1						
STA3	10/25/2010		2.0						10.50	13.0						
STA3	10/25/2010		3.0						10.54	12.9						
STA3	10/25/2010		4.0						10.53	12.9						
STA3	10/25/2010		5.0						10.51	12.9						
STA3	10/25/2010		6.0						10.51	12.8	7.08	0.8	4.04	2.83	0.45	32.26
STA4	10/25/2010	2	0.5	4.80	3.10	3.05	3.08	64.1%	10.27	13.1	7.21	0.9	3.88	2.49	0.52	37.58
STA4	10/25/2010		1.0						10.27	13.1						
STA4	10/25/2010		2.0						10.28	13.0						
STA4	10/25/2010		3.0						10.22	12.8						
STA4	10/25/2010		4.0						10.18	12.7	7.20	0.9	3.13	1.95	0.53	31.66
STA5	10/25/2010	2	0.5	6.10	2.30	2.14	2.22	36.4%	10.06	14.0	7.28	0.9	8.84	3.18	0.30	31.07
STA5	10/25/2010		1.0						10.16	13.6						
STA5	10/25/2010		2.0						10.13	13.5						
STA5	10/25/2010		3.0						10.09	13.3						
STA5	10/25/2010		4.0						9.98	13.2						
STA5	10/25/2010		5.0						9.95	13.1	7.19	0.9	6.97	4.82	0.39	32.11